

**TEMPERATURE CONTROLLED CABINET SYSTEM AND METHOD FOR
HEATING ITEMS TO DESIRED TEMPERATURES**

1 CROSS-REFERENCE TO RELATED APPLICATIONS

2 This application claims priority from U.S. Provisional Patent Application Serial
3 No. 60/158,507, entitled "Temperature Controlled Cabinet System and Method for
4 Heating Items to Desired Temperatures", and filed October 8, 1999. The disclosure of
5 the above-mentioned provisional application is incorporated herein by reference in its
6 entirety.

8 BACKGROUND OF THE INVENTION

9 **1. Technical Field**

10 The present invention pertains to systems for heating medical items. In particular,
11 the present invention pertains to a system for heating and maintaining medical solution
12 containers (e.g., bags or bottles containing saline or intravenous (IV) solutions,
13 antibiotics or other drugs, blood, etc.) or other medical items (e.g., instruments, blankets,
14 etc.) at desired temperatures by providing an even distribution of heat to the medical
15 items placed within the system.

17 **2. Discussion of Related Art**

18 Generally, various items are required to be heated prior to utilization in a medical
19 procedure to prevent thermal shock and injury to a patient. These items typically include
20 intravenous solution, surgical instruments, bottles and blankets. In order to provide the
21 necessary heated items for use in medical procedures, medical personnel may utilize
22 several types of warming systems to heat items toward their operational temperatures.
23 For example, ovens may be disposed within operating rooms to heat items to desired
24 temperatures. Further, U.S. Patent No. 4,419,568 (Van Overloop) discloses a wet
25 dressings heater having a base with side walls defining a cavity, and an insert connected
26 to the base and defining at least one recess in the cavity for receiving wet dressings. A
27 heater has an electrical heating element in close proximity to the insert recess for heating

1 the wet dressings, while the temperature of the heating element is controlled in a desired
2 temperature range for those wet dressings.

3 U.S. Patent No. 4,495,402 (Burdick et al) discloses a warmer for heating wet
4 dressings and other articles disposed within a heating and storage compartment. The
5 articles are arranged within the compartment in stacked relation and disposed on a plate
6 that is supplied with thermal energy from a heater. The plate includes a center aperture
7 whereby a first thermal sensor is disposed in the aperture in contact with a bottommost
8 article. Control circuitry is disposed beneath the plate to control the heater to maintain
9 temperature of the bottommost article at a desired level based on the temperatures sensed
10 by the first thermal sensor and a second thermal sensor responsive to heater temperature.

11 U.S. Patent No. 5,408,576 (Bishop) discloses an intravenous fluid warmer having
12 a cabinet structure to accommodate a plurality of intravenous fluid bags. A temperature
13 sensor and pad of heating filaments are disposed within the cabinet structure, whereby
14 the temperature sensor enables automatic temperature regulation of the pad of heating
15 filaments to heat the intravenous fluid bags. The heating filaments are covered by a
16 rubber layer to prevent melting of the bags during heating. A temperature indicator
17 disposed on the cabinet structure permits a user to ascertain when a desired temperature
18 is attained, whereby an intravenous fluid bag is removed from the intravenous fluid
19 warmer via an opening defined in a side of the cabinet structure.

20 U.S. Patent No. 5,986,239 (Corrigan, III et al.) discloses a conductive warmer for
21 flexible plastic bags. The warmer includes a heat-conducting member of thermally
22 conductive material having a plurality of fins which are parallel and spaced apart to
23 define a plurality of bag-receiving compartments. The fins are connected to a back
24 portion of the heat-conducting member to which a heating element is attached in a heat-
25 exchanging relationship. The heating element conducts heat through the back portion
26 and fins of the heat-conducting member to the bags.

27 In addition, the related art provides warming systems for other types of items. For
28 example, U.S. Patent No. 4,605,840 (Koopman) discloses a horizontal holding cabinet
29 for prepared food, wherein the cabinet has a plurality of drawer-containing modules
30 arranged side-by-side to each other. Each module has a heating element and an integral
31 water reservoir and is capable of being independently heated and humidified. The
32 modules each further include a drawer receiving cavity having an open front adapted to

1 receive a drawer frame. The cavity bottom wall is provided with one or more heating
2 elements, whereby the module walls conduct heat to heat the cavity. A temperature
3 thermostat is mounted on the undersurface of the cavity bottom wall to sense cavity
4 temperature and is further connected to a thermostatic controller that controls the heating
5 elements in accordance with a desired temperature.

6 The warming systems described above suffer from several disadvantages. In
7 particular, ovens typically do not have a high degree of accuracy or control, thereby
8 enabling use of items having temperatures incompatible with a medical procedure and
9 possibly causing injury to a patient. Further, the Burdick et al and Bishop warmers
10 employ heaters that generally contact a particular portion of an article being heated,
11 thereby heating articles in an uneven manner and enabling formation of hot spots.
12 Moreover, the Burdick et al, Bishop, Corrigan, III et al and Van Overloop warming
13 systems heat items simultaneously to only a single desired temperature rendering them
14 incompatible for applications requiring various items to be heated to different
15 temperature ranges. These systems further employ a heating element covering a
16 substantial portion of a conducting member, thereby increasing system costs and power
17 usage. The above described systems typically have heating area dimensions specifically
18 configured to accommodate particular items and, therefore, are limited with respect to
19 the types of items that may be heated by those systems. The Koopman system employs
20 heating elements disposed within a housing cavity and not in direct contact with the
21 surface supporting an item. This typically requires the system to heat the cavity, thereby
22 providing increased heating time for an item to attain a particular temperature. In
23 addition, the above-described warming systems do not provide a selectively configurable
24 structure for partitioning system compartments to facilitate a relatively even heat
25 distribution for additional or varying items placed therein.

26 The present invention overcomes the aforementioned problems and provides
27 several advantages. For example, the present invention warming system distributes heat
28 evenly to one or more medical items of varying shapes and sizes, thereby ensuring
29 relatively uniform heating of items with enhanced temperature control. Further, since
30 medical items are supported within system compartments on a heating plate, the medical
31 items are not in direct contact with a heater, thereby avoiding creation of "hot spots".
32 Moreover, the present invention reduces costs by utilizing a single common controller

1 to simultaneously control each heater within system compartments, and provides
2 versatility since each compartment heater may be individually controlled to enable the
3 system to heat medical items contained within different compartments to the same or
4 different desired temperatures. In addition, a warming system rack structure of the
5 present invention provides even heat distribution and enhanced temperature regulation
6 of individual medical items contained within the receptacles. Since most hospital
7 personnel are unaware of the temperature of a particular medical item prior to use, the
8 rack structure provides a fairly high degree of control of that temperature.

9

10 **OBJECTS AND SUMMARY OF THE INVENTION**

11 Accordingly, it is an object of the present invention to heat a medical item to a
12 desired temperature by uniformly distributing heat about the medical item, thereby
13 avoiding creation of "hot spots" and "cold spots".

14 It is another object of the present invention to simultaneously maintain various
15 items at different desired temperatures for use in medical procedures.

16 Yet another object of the present invention is to simultaneously maintain various
17 items at different desired temperatures for use in medical procedures via a temperature
18 control system including heating compartments individually controlled by a common
19 controller, wherein each heating compartment is maintained at a desired temperature.

20 Still another object of the present invention is to evenly distribute heat about a
21 medical item within a heating compartment of the system by conducting heat through a
22 heating plate that at least partially surrounds the medical item.

23 A further object of the present invention is to provide a collapsible rack structure
24 within a system heating compartment to partition that compartment and facilitate a
25 uniform distribution of heat to additional or varying items.

26 The aforesaid objects may be achieved individually and in combination, and it is
27 not intended that the present invention be construed as requiring two or more of the
28 objects to be combined unless expressly required by the claims attached hereto.

29 According to the present invention, a temperature control system includes a
30 cabinet or system housing having an interior partitioned into individual heating
31 compartments for containing medical items. Each compartment includes a heating
32 assembly having a generally U-shaped heating plate with thermally conductive bottom

1 and side walls, a heater, a temperature sensor and a temperature cut-out switch. The
2 heater is typically disposed beneath the bottom wall of the heating plate and applies heat
3 to the heating plate to heat medical items placed thereon. The U-shaped configuration
4 of the heating plate ensures even distribution of heat applied to one or more medical
5 items placed within the heating compartment. The system further includes a controller
6 in communication with the heater and temperature sensor of each heating assembly,
7 wherein the controller controls heating of each compartment based upon a user selected
8 desired or set point temperature associated with that compartment. A collapsible rack
9 structure may additionally be disposed within one or more compartments to form
10 individual receptacles in those compartments for receiving and heating medical items
11 placed therein.

12 The above and still further objects, features and advantages of the present
13 invention will become apparent upon consideration of the following detailed description
14 of specific embodiments thereof, particularly when taken in conjunction with the
15 accompanying drawings, wherein like reference numerals in the various figures are
16 utilized to designate like components.

17

18 **BRIEF DESCRIPTION OF THE DRAWINGS**

19 Fig. 1 is a view in perspective of a temperature controlled cabinet system in
20 accordance with the present invention.

21 Fig. 2 is an exploded perspective view of a cabinet or housing of the system of
22 Fig. 1.

23 Fig. 3 is a view in perspective of a heating assembly of the system of Fig. 1.

24 Fig. 4 is a view in plan of the underside of a heating plate of the heating assembly
25 of Fig. 3.

26 Fig. 5 is an electrical schematic diagram of an exemplary control circuit of the
27 system of Fig. 1.

28 Fig. 6 is a view in perspective of an alternative cabinet or housing for the system
29 of Fig. 1.

30 Fig. 7a is a view in elevation of the system of Fig. 1 including collapsible rack
31 structures for containing medical items, the rack structures being illustrated in fully and
32 partially collapsed states.

Fig. 7b is a view in elevation of the system of Fig. 7a with the rack structures in fully and partially expanded states.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A temperature controlled cabinet system for heating and maintaining medical solution containers (e.g., bags or bottles containing saline or intravenous (IV) solutions, antibiotics or other drugs, blood, etc.) or other medical items (e.g., instruments) at desired temperatures is illustrated in Fig. 1. Specifically, temperature controlled cabinet system 502a includes a cabinet or system housing 504a having a shelf 506 partitioning the cabinet interior into upper and lower compartments 524, 526, respectively. Each compartment includes a respective heating assembly 508(1), 508(2) for receiving medical items placed within that compartment and heating the medical items to a desired temperature. Cabinet 504a is generally in the form of a rectangular box and includes top and bottom walls 510, 512, side walls 514, 516, a front door 528, a front wall 518 disposed above the door, and rear wall 520. The cabinet walls and door are each substantially rectangular and collectively define a cabinet interior. Rollers or casters 519 are attached to the cabinet bottom wall with each caster disposed toward a corresponding cabinet bottom wall corner to enable the system to be transportable. The casters or rollers may be of any quantity, may be implemented by any conventional or other types of rollers or wheel-type structures, and may be disposed at any locations on the cabinet. Further, the cabinet may be constructed of electro-galvanized steel or other suitably sturdy material, and may be of any size or shape. However, by way of example only, the cabinet system has an approximate height of thirty-six inches. It is to be understood that the terms "top", "bottom", "side", "front", "rear", "horizontal", "vertical", "upper", "lower", "up", "down", "height", "length", "width", "depth" and the like are used herein merely to describe points of reference and do not limit the present invention to any specific orientation or configuration.

Compartments 524 and 526 are generally disposed in vertical alignment within the cabinet interior. Heating assembly 508(1) is disposed on shelf 506 within compartment 524, while heating assembly 508(2) is disposed on bottom wall 512 within compartment 526. The heating assemblies are each controlled by a common system controller 522 that enables entry of a desired or set point temperature for each heating

1 assembly and controls heating of medical items residing within each compartment based
2 on the associated set point temperature as described below. Controller 522 is disposed
3 toward an intermediate section of front wall 518, while a power switch 523 is generally
4 disposed in the front wall lower portion toward side wall 516. A fuse 584 is typically
5 further disposed in the front wall above power switch 523, but may alternatively be
6 disposed in rear wall 520. The power switch enables power to the controller for heating
7 medical items placed within the compartments, while the fuse protects the cabinet from
8 power surges. Cabinet 504a may include any quantity of compartments, rollers, shelves,
9 power switches, controllers and accompanying control circuitry, while the cabinet
10 components (e.g., walls, door, shelf, panels, etc.) may be arranged in any fashion.

11 Door 528 includes a handle (not shown) typically disposed toward an
12 intermediate section side edge. The handle may be implemented by any conventional or
13 other type of handle. Alternatively, the handle may be disposed on the door at any
14 suitable location. Door 528 generally pivots toward and away from the cabinet as
15 described below, and may be constructed of electro-galvanized steel or other suitably
16 sturdy material. The door may include an opening covered by a substantially transparent
17 material, such as glass or plexiglass, to serve as a window to enable viewing of the
18 medical items and maintain heat within the cabinet. The door, opening and transparent
19 material may be of any size or shape.

20 An exemplary configuration for cabinet 504a is illustrated in Fig. 2. Specifically,
21 cabinet 504a includes a body 530, top and bottom walls 510, 512, shelf 506 and door
22 528. Body 530 includes rear wall 520 interconnected to side walls 514, 516, thereby
23 collectively defining compartment interiors. Rear wall 520 includes a substantially
24 rectangular opening 538 defined in an upper portion thereof to permit air to cool circuitry
25 contained within the cabinet upper portion as described below. Side walls 514, 516 each
26 include a ledge 546, 548 defined at a side wall front edge. Ledges 546, 548 extend
27 inwardly and substantially perpendicular to the respective side walls, and enhance
28 interconnection of cabinet components.

29 A substantially rectangular cover 532 is disposed within and attached to the body
30 slightly below the rear and side wall top edges to define a ceiling of upper compartment
31 524. Top wall 510 is placed over and attached to the top edges of the rear and side walls
32 with front wall 518 extending down from the top wall front edge to the cover. The front

1 wall includes appropriate openings 540, 542, 544 for receiving the controller, power
2 switch, and fuse respectively. The cover and top, side, front and rear walls collectively
3 define a chamber above compartment 524 for housing the system control circuitry
4 described below. Opening 538 within rear wall 520 permits air to enter the chamber to
5 cool the circuitry. The opening may be of any quantity, shape or size, and may be
6 defined at any locations within the rear, side and front walls.

7 Shelf 506 is inserted within and attached to an intermediate section of the body
8 to form compartments 524, 526 within the cabinet interior. The shelf may include
9 multiple holes to enhance dissipation of heat within the cabinet. Door 528 includes
10 substantially rectangular members 534, 536 each having openings defined therein for
11 attachment of a handle (not shown). The door is attached to side wall 516 via
12 conventional hinge mechanisms and typically pivots toward and away from the cabinet
13 to permit access to the cabinet interior. The various cabinet components (e.g., walls,
14 cover, shelf, door, etc.) may be of any shape or size, and may be constructed of any
15 suitably sturdy materials. The components may be interconnected by any conventional
16 or other fastening techniques, such as welding, molding or bending, fasteners (e.g.,
17 screws, bolts, nuts, etc.).

18 Heating assemblies 508(1), 508(2) are each disposed within a corresponding
19 cabinet compartment to heat medical items placed therein as described above. Each
20 heating assembly includes an exemplary configuration as illustrated in Fig. 3.
21 Specifically, heating assemblies 508(1), 508(2) each include a heating plate 549 having
22 a heater 558, a temperature sensor 560 and temperature cut-out switch 562. The heating
23 plate protects the heater from medical items (e.g., containers melting and becoming
24 attached to the heater), and includes a thermally conductive bottom wall 550 and
25 thermally conductive side walls 552, 554. The bottom and side walls are each generally
26 rectangular with the side walls extending from opposing bottom wall edges and forming
27 rounded junctions where the side wall and bottom walls meet. The side walls extend
28 upward from the opposing bottom walls edges and generally along walls of a
29 corresponding compartment to form a generally U-shaped heating plate configuration.
30 The bottom wall is generally flat for receiving and containing medical items thereon and
31 extends along the bottom of a corresponding compartment. Legs 556 are attached to the
32 underside of bottom wall 550 with each leg disposed toward a corresponding bottom wall

1 corner. The legs elevate the heating plate above the corresponding compartment bottom
2 (e.g., shelf 506 for compartment 524, or bottom wall 512 for compartment 526) to
3 prevent the heater from contacting the cabinet. The legs may be of any quantity, shape
4 or size, and may be disposed at any suitable locations. The front portion of bottom wall
5 550 includes a substantially rectangular protective panel 564 extending down from a
6 front edge of the heating plate bottom wall. The protective panel prevents users from
7 gaining access to the heater, thereby preventing user injury.

8 Heater 558 and associated assembly components are typically disposed on the
9 underside of bottom wall 550 as illustrated in Fig. 4. Specifically, heater 558 is disposed
10 on the underside of the bottom wall and applies heat to the heating plate. The heat
11 applied by the heater is conducted by the heating plate bottom and side walls to provide
12 an even heat distribution to the medical items residing on the heating plate, thereby
13 preventing localized heating of the medical items. Further, since the medical items are
14 not in direct contact with the heater, this arrangement avoids creation of "hot spots".
15 Alternatively, the heater may be disposed at any locations on the side or bottom walls of
16 the heating plate.

17 The heater is preferably configured to cover only a portion of the heating plate
18 bottom wall, and is generally rectangular having truncated corners and a generally
19 rectangular opening 565. The heater is preferably implemented by a conventional etched
20 foil silicon rubber heating pad, while a connector (not shown) facilitates connections for
21 the heater. The heater further includes a pressure sensitive or other type of adhesive for
22 attachment to the heating plate bottom wall. The heater may be of any quantity (e.g., at
23 least one), shape, or size, and may include any configuration that covers the entirety or
24 a portion of a corresponding heating plate bottom wall (e.g., strips, bars, segments,
25 include various openings, etc.). In addition, the heater may be implemented by any
26 conventional or other type of heater or heating element (e.g., heating coils) to heat the
27 heating plate.

28 Temperature sensor 560 is typically disposed on the underside of the heating plate
29 bottom wall, generally within the confines of the heater (e.g., the portion of the heater not
30 covering the bottom wall). The temperature sensor is preferably implemented by a
31 conventional RTD temperature sensor (e.g., 1,000 Ohm RTD) and measures the
32 temperature of the heating plate bottom wall. However, the temperature sensor may be

implemented by any conventional or other type of temperature sensor, and may be disposed at any suitable location on the heating plate or within a compartment, thereby obviating the need for an internally mounted temperature sensor on the heating element. The temperature measurement of sensor 560 is provided to the controller for control of the heater as described below. In addition, a temperature sensitive cut-out switch 562 is disposed on bottom wall 550 within the confines of the heater. The cut-out switch basically disables current to heater 558 in response to a temperature measurement exceeding a temperature threshold. In other words, the cut-out switch disables the heater in response to detection of excessive heater temperatures. The cut-out switch may be implemented by any conventional switching type or limiting devices, such as a high limit thermostat, and may be disposed at any suitable locations.

Referring back to Fig. 1, controller 522 typically includes a display 574 (e.g., LED or LCD), and a plurality of input devices or buttons 576 for enabling entry of desired or set point temperatures for the corresponding compartments. The input devices are manipulated to enable entry of the set point temperatures, while display 574 may indicate the actual temperature of each heating plate bottom wall measured by a corresponding temperature sensor 560 (Fig. 4) or the set point temperatures entered by the operator. Display 574 typically displays the measured temperature of each heating plate, and may be directed, via the input devices, to display the set point temperatures.

The heating plates of each compartment are typically heated to the same temperature, but the temperatures may be different depending upon the medical items to be heated. Since the quantity or types of medical items placed in each compartment may differ, separate heating controls for the compartments are required. Accordingly, controller 522 provides independent control for each heating assembly and essentially implements a feedback control loop to control heating of those compartments. Specifically, controller 522 includes inputs for receiving temperature signals from temperature sensor 560 of each heating assembly indicating the temperature of a corresponding heating plate bottom wall. In response to the measured temperature of a heating plate bottom wall being equal to or exceeding the set point temperature entered for a corresponding compartment, the controller disables power to the heater associated with that compartment via a solid state relay described below. Conversely, when the measured temperature of the heating plate bottom wall is below the set point temperature

1 entered for the corresponding compartment, the controller enables power to the heater
2 associated with that compartment via the solid state relay. The controller is generally
3 pre-programmed with a fuzzy logic or other type of control algorithm to control each
4 heating assembly based on the measured temperature of the corresponding heating plate
5 bottom wall. Controller 522 is preferably implemented by a 32A Series
6 Temperature/Process Controller manufactured by Love Controls, a Division of Dwyer
7 Instruments, Inc. Generally, this type of controller provides single set point capability for
8 a process, or dual set point capability (e.g., dependent high and low set points) for the
9 same process, and displays the set point and actual or process temperatures. However,
10 in order to employ this type of controller within the present invention, the 32A Series
11 Controller has been slightly modified. In particular, the alarm relay and associated
12 circuits of the 32A Series Controller have been removed to permit insertion of loop
13 circuitry, thereby enabling independent operation of plural set points. Further, the 32A
14 Series Controller has been modified to display the actual temperature of each heating
15 plate, while the set point temperatures entered for the compartments may be displayed
16 by manipulating input devices 576. In addition, the options typically available for the
17 32A Series Controller have not been enabled. It is to be understood that controller 522
18 may be implemented by any conventional or other processor or circuitry utilizing any
19 control algorithm to control the heating assemblies, whereby controller 522 or other
20 processor or circuitry may accommodate any quantity of heaters, compartments or set
21 points.

22 An exemplary control circuit of the temperature controlled cabinet system is
23 illustrated in Fig. 5. Specifically, system control circuit 577 includes power conductors
24 580, 582, power switch 523, controller 522 and solid state relays 588, 589. The solid
25 state relays are each associated with a corresponding heater 558 of heating assemblies
26 508(1), 508(2). Power conductors 580, 582 enable power to the circuit with conductor
27 580 typically supplying a positive potential, while conductor 582 provides a negative or
28 reference potential. Fuse 584 is connected in series with conductor 580 to prevent power
29 surges from damaging the circuitry. Power switch 523 is connected to conductor 580 and
30 in series with fuse 584, and may include a light 581 to illuminate the switch. The power
31 switch is further connected to conductor 582 and controller 522 to enable power to the
32 controller.

1 Controller 522 receives power from power switch 523 and is further connected
2 to solid state relays 588, 589 and temperature sensor 560 and heater 558 of each heating
3 assembly 508(1), 508(2). Temperature sensor 560 of each heating assembly measures
4 temperature of a corresponding heating plate bottom wall and transmits a signal to
5 controller 522 indicating that temperature. The controller controls each solid state relay
6 588, 589 to enable or disable power to a corresponding heater 558 in response to the
7 temperature measured for the associated heating plate as described above. The solid state
8 relays are each connected to controller 522 and a terminal block 568 disposed between
9 the power switch and controller, between the controller and solid state relays, and
10 between the controller and heater of each heating assembly 508(1), 508(2). The terminal
11 block receives wiring from the solid state relays, power switch, controller and each
12 heating assembly heater and facilitates connections between the wiring. Fuses 586, 587
13 are respectively connected between solid state relays 588, 589 and the terminal block to
14 prevent damage to the relays and corresponding heaters.

15 Temperature cut-out switch 562 of each heating assembly is connected between
16 a heater 558 of that heating assembly and a corresponding solid state relay. The cut-out
17 switch disables current to a corresponding heater in response to detecting the heater
18 temperature in excess of a predetermined temperature threshold. Control circuit 577 may
19 be implemented by any conventional circuitry components performing the above-
20 described functions.

21 Operation of the temperature controlled cabinet system is described with
22 reference to Figs. 1 and 5. Initially, an operator selects medical solution containers (e.g.,
23 bags or bottles containing saline or intravenous (IV) solutions, antibiotics or other drugs,
24 blood, etc.) or other medical items (e.g., instruments) for heating within the cabinet and
25 determines appropriate temperatures for the items. The operator subsequently enables
26 power switch 523, whereby the operator grasps and applies force to the door handle to
27 pivot the door outward from the cabinet interior to an open position. The medical items
28 are disposed on any quantity (e.g., at least one) or combination of heating assemblies
29 508(1), 508(2) within the compartments. The door is subsequently pivoted towards the
30 cabinet to a closed position. The desired or set point temperatures are entered into
31 controller 522 via input devices or buttons 576. The controller receives signals from the
32 temperature sensor of each heating assembly and determines appropriate controls for a

1 corresponding solid state relay 588, 589 to enable or disable power to an associated
2 heater as described above. Each heater 558 applies heat to a corresponding heating plate
3 bottom wall, whereby the side walls of that heating plate conduct heat from the bottom
4 wall to evenly distribute the heat to the medical items contained therein as described
5 above.

6 Controller 522 displays the heating plate bottom wall temperature of each heating
7 assembly measured by a corresponding temperature sensor 560, and may be further
8 directed to alternatively display the set point temperature entered for the compartments
9 based on manipulation of input devices 576. When the medical items have attained the
10 desired temperatures, the door is pivoted to an open position as described above, whereby
11 the heated medical items are removed from the compartments for use, while the door is
12 subsequently returned to a closed position. Further, additional medical items may replace
13 the removed items within the compartments for heating by the system. The medical
14 items may be loaded into the system several hours before the items are required for use
15 (e.g., the items may be placed within the system the night prior to use in a medical
16 procedure) so that the items, such as intravenous (IV) solution bags, may attain their
17 operational temperature and be available for immediate use by the required time. It is to
18 be understood that either or both of the compartments may be used and independently
19 controlled in substantially the same manner described above to maintain medical items
20 at the same or different desired temperatures. Moreover, any quantity of items may be
21 disposed within the compartments for heating by the cabinet.

22 An alternative configuration for cabinet 504a is illustrated in Fig. 6. Cabinet
23 504b is substantially similar to cabinet 504a described above except that cabinet 504b
24 includes a chamber on its top surface for housing system control circuitry. Specifically,
25 cabinet 504b is generally in the form of a rectangular box having a raised chamber
26 defined on its top surface. The cabinet includes front door 528, cover 532, front panel
27 595, bottom and rear walls 512, 590, side walls 594, 596 and top panel 592. The cabinet
28 front door, cover and bottom wall are each as described above, while the cabinet front
29 door, cover and bottom and side walls collectively define the cabinet interior. Shelf 506
30 is disposed within the cabinet interior at an intermediate cabinet section to partition the
31 cabinet interior into upper and lower compartments 524, 526 as described above. Each
32 compartment includes a respective heating assembly 508(1), 508(2) for receiving and

1 heating medical items placed thereon in substantially the same manner described above.
2

3 Front panel 595 is substantially rectangular and is attached to and extends upward
4 from an intermediate section of cover 532. The front panel is tilted slightly rearward and
5 has a longer dimension similar to the transverse dimension of cover 532. Rear wall 590
6 is substantially rectangular and is attached to side walls 594, 596, cover 532 and bottom
7 wall 512. The rear wall extends from the bottom wall toward the upper edge of front
8 panel 595. Top panel 592 is substantially rectangular and is attached to and disposed
9 between the upper edges of the front panel and rear wall. Side walls 594, 596 are
10 generally rectangular and are attached to and extend between the bottom wall and cover.
11 The side walls partially extend beyond the cover for attachment to top panel 592, and are
12 further attached to and disposed between the front panel and rear wall. The top panel,
13 front panel, cover and side and rear walls collectively define a chamber on the cover top
14 surface to house the system circuitry. Front panel 595 further includes controller 522
15 disposed toward a front panel central portion and power switch 523 disposed toward a
16 front panel upper edge near side wall 594. Fuse 584 (not shown) is typically disposed
17 on rear wall 590. System 502b functions in substantially the same manner described
above for system 502a to heat items placed therein.

18 In addition, the cabinet systems described above may further include a collapsible
19 rack structure disposed within the cabinet compartments to contain items as illustrated,
20 by way of example only, in Figs. 7a - 7b. System 502c is substantially similar to system
21 502a described above for Figs. 1 - 5, and further includes a collapsible rack structure.
22 Specifically, compartments 524, 526 each include a series of supports 527, 537 disposed
23 on the interior surface of rear wall 520. The supports are substantially rectangular having
24 a narrow transverse or shorter dimension to essentially form ledges within each
25 compartment protruding from the rear wall. The supports extend substantially in parallel
26 and are vertically spaced from each other a slight distance.

27 Upper leaves 525, 529 are disposed within each compartment 524, 526 and are
28 attached to side walls 514, 516, respectively, with a corresponding support 527 disposed
29 between those leaves. Similarly, lower leaves 535, 539 are disposed within each
30 compartment 524, 526 and are attached to side walls 514, 516, respectively, below leaves
31 525, 529 with a corresponding support 537 disposed between the lower leaves. Each
32 upper and lower leaf includes a pair of substantially rectangular board members attached

1 to each other by a hinge type mechanism, thereby permitting each leaf to be folded and
2 placed against the cabinet side wall.

3 Each compartment 524, 526 includes a divider bar 517 and a bar holder 547. Bar
4 holder 547 may be implemented by any conventional or other securing or clasping
5 mechanism and secures the bar within each compartment. Bar holder 547 within
6 compartment 524 is attached to the underside of cover 532, while the bar holder within
7 compartment 526 is attached to the underside of shelf 506. However, the bar holders
8 may be of any quantity, shape or size, and may be disposed in any suitable locations. Bar
9 517 includes a plurality of hinged sections that enable the bar to expand and collapse or
10 fold for storage within a corresponding bar holder (Fig. 7a). Bar 517 includes a narrow
11 transverse or shorter dimension, and is attached to a corresponding holder within each
12 compartment 524, 526. When in an expanded state, the bar extends down from a
13 corresponding holder within a compartment toward the front of the cabinet. The bar
14 essentially provides a vertical divider toward the front portion of each compartment that
15 is generally perpendicular to the unfolded leaves, and the bar includes ledges (not shown)
16 disposed coincident supports 527, 537 within that compartment. The bar ledges and rear
17 wall supports within a compartment provide support for the upper and lower leaves of
18 that compartment, thereby forming individual receptacles. Heating assemblies 508(1),
19 508(2) are respectively disposed on the shelf and bottom wall within compartments 524,
20 526 to heat medical items placed in the compartments as described above. The side walls
21 of each heating plate typically extend from the heating plate bottom wall to a point
22 slightly below respective supports 537 and lower leaves 535, 539 to enable the rack
23 structure to accommodate the heating assemblies. Alternatively, the upper and lower
24 leaves within a compartment may be connected to the side walls of the heating plate of
25 a corresponding heating assembly to form the rack structure.

26 The rack structure may be utilized within a compartment by extending bar 517
27 down from holder 547. The bar ledges and rear wall supports provide support for the
28 distal portions of the upper and lower leaves as described above. Each upper and lower
29 leaf may be unfolded and placed on a corresponding rear wall support and bar ledge to
30 form individual receptacles within the compartment. Medical items may be placed in one
31 or more of the receptacles for heating. The rack structure provides an even heat
32 distribution from the heating assembly to the individual medical items placed within the

1 receptacles. A convective flow of heat is developed around the medical items supported
2 in the rack structure, and the system may further include a fan to enhance this flow and
3 provide forced air convection. In order to collapse the rack, the upper and lower leaves
4 are folded and placed against the compartment side walls, while the bar is collapsed and
5 placed in the bar holder.

6 Any portion of the rack structure may be utilized within a compartment to heat
7 medical items. For example, the bar and upper and lower leaves within a compartment
8 may remain in their collapsed states, and medical items may be placed on the heating
9 assembly for heating as described above (e.g., compartment 524 as shown in Fig. 7a).
10 Conversely, a bar may be extended within a compartment with each upper and lower leaf
11 of that compartment unfolded to form several receptacles for heating items (e.g.,
12 compartment 524 as shown in Fig. 7b). In addition, a bar may be extended within a
13 compartment with some of the upper and lower leaves of that compartment unfolded to
14 form receptacles to heat items, while additional items may be placed on the heating
15 assembly for heating as described above (e.g., compartment 526 as shown in Figs. 7a -
16 7b). Any portion of the rack structure within any compartment may be expanded for use
17 as described above. The rack structure components (e.g., supports, leaves, bar, bar
18 holder, etc.) may be of any shape or size, and may be constructed of any suitable
19 materials (e.g., conductive or non-conductive materials, such as plastic coated wiring,
20 metal bars or rods, etc.). The rack structure may include any quantity of components
21 (e.g., supports, leaves, bars, bar holders, etc.) of any shape or size to partition a
22 compartment into any quantity of receptacles. The receptacles may be of any shape or
23 size and may contain any quantity of medical items. In addition, the rack structure may
24 be utilized in any of the cabinet systems described above, and may be implemented by
25 any structures or devices partitioning compartment interiors into individual receptacles.
26 For example, a pre-formed rack may be placed within the compartments to contain
27 medical items for heating.

28 It will be appreciated that the embodiments described above and illustrated in the
29 drawings represent only a few of the many ways of implementing a temperature
30 controlled cabinet system and method for heating items to desired temperatures.

31 The present invention systems may be of any shape or size and may be
32 constructed of any suitable materials. The systems may include any quantity (e.g., at

least one) of compartments having any shape or size and located within the housing at any suitable locations. The housing body components (e.g., walls, shelves, door, panels, etc.) of the systems may be of any shape or size, may be constructed of any suitable materials and may be interconnected via any conventional or other attachment techniques (e.g., welding, fasteners, constructed as an integral unit, etc.). The systems may warm any quantity of any types of medical or other items, where the items may be placed within any quantity or combination of compartments. The systems generally heat medical items to a normal body temperature in the approximate of 86°F - 104°F, however the systems may heat any types of items to any desired temperatures.

The controller of the systems may be implemented by any conventional or other microprocessor, controller or circuitry performing the functions described above. The controller may be disposed on or within the systems at any suitable location. The controller may control the heaters to any desired temperatures. The controller may include any quantity of any type of input device (e.g., keys, buttons, mouse, voice, etc.) to facilitate entry of desired temperatures. The controller may include any type of display of any shape or size to convey any desired information. The display may be integral with or detached from the controller or systems. The systems may include any quantity of controllers, while the controller may control heating of any quantity of compartments or heating assemblies. The controller may utilize any conventional or other control algorithms (e.g., fuzzy logic, PID, etc.).

The door may be of any shape or size, may be constructed of any suitable materials, and may pivot in any desired direction via any conventional or other pivoting or hinged mechanisms to facilitate placement and removal of items within the systems. Further, the door may include a window of any size or shape having any type of partially or fully opaque, translucent or transparent material. The door may include any quantity of any type of handle disposed at any suitable locations.

The heating plate of the heating assembly may be of any configuration that surrounds the medical items placed within the system. The plate may be of any shape or size, may include any quantity of conducting and/or non-conducting walls and may be constructed of any suitable materials. The bottom and side walls may be of any shape, while the side walls may extend at any angle for any desired distance. The plate may include any quantity of legs disposed at any suitable locations. The legs may be of any

1 shape or size and may be constructed of any suitable materials. Alternatively, the heating
2 plate may be elevated from a compartment floor by any conventional or other techniques
3 (e.g., suspended or affixed to compartment walls, etc.). The protective plate may be of
4 any size or shape, may be constructed of any suitable materials, and may be disposed at
5 any location to prevent a user from contacting the heater. The heating assembly may be
6 utilized with or without the protective plate.

7 The heater may be implemented by any conventional heater or other heating
8 device. The heating plate may include any quantity of heaters arranged in any
9 configurations (e.g., strips, annular, segments, etc.) and disposed at any suitable locations
10 for applying heat. The heater may be attached to the heating plate via any conventional
11 or other fastening techniques (e.g., pressure sensitive or other adhesives, etc.). The
12 systems may alternatively include any quantity of heaters disposed at any suitable
13 locations within or proximate a compartment.

14 The temperature sensor may be implemented by any conventional or other
15 temperature measuring device (e.g., RTD, infrared, etc.) and be disposed at any suitable
16 location on the heating plate or within or proximate a compartment. The cut-out switch
17 may be implemented by any conventional or other limiting device and may be set to
18 function at any desired temperature. The cut-out switch may be disposed at any location
19 on the heating plate or within or proximate a compartment. The heater and other circuitry
20 may utilize any conventional or other connectors or wiring to transfer power and other
21 signals to system components. Further, the power switch, relays, fuses, terminal block
22 and other control circuit components may be implemented by any conventional or other
23 electrical components performing the functions described above. The circuit may be
24 disposed at any location and arranged in any fashion to control heating of the
25 compartments as described above. Moreover, the control circuit may include any type
26 of components to perform the functions described above. The power switch, fuse and
27 controller may be disposed and arranged in any fashion on the housings of the systems.

28 The rack structure of the present invention may be of any shape or size, may be
29 constructed of any suitable materials and may be configured to include any quantity of
30 receptacles. The rack structure may include any quantity of leaves and supports of any
31 size and shape, constructed of any suitable materials and disposed at any suitable
32 locations. The leaves may include any conventional or other folding or collapsing

1 mechanisms (e.g., hinges, etc.) and may collapse or fold in any fashion. Alternatively,
2 the leaves may each be non-folding (e.g., unable to be folded or collapsed) and pivot
3 toward and away from compartment walls to provide a selective configuration. Further,
4 the leaves may be attached to the heating plate at any suitable locations via any
5 conventional or other fastening techniques. The rack structure may be an independent
6 unit and may be removably disposed within a system compartment. The divider bars
7 and bar holders may be of any quantity, size and shape and may be disposed at any
8 location within a system compartment. The divider bars may be collapsible via any
9 conventional or other techniques (e.g., hinges or other folding or collapsing mechanisms,
10 etc.) and may collapse or fold in any fashion. The bar holder may include any
11 conventional or other securing mechanism (e.g., bracket, clasp, etc.) for receiving and
12 securing a divider bar. The rack structure may include any quantity of receptacles of any
13 shape or size for containing any quantity of any type of medical or other items. The rack
14 structure may be selectively configured to form any quantity of receptacles where any
15 quantity of leaves may be manipulated in any combination to form those receptacles.

16 The present invention systems may be used at any suitable location (e.g., hospital
17 or other medical facility, emergency medical or other vehicles, etc.) to heat any quantity
18 of any type of medical or other items. The systems may be transportable and include any
19 quantity of any type of rollers or casters disposed at any suitable locations. In addition,
20 medical or other equipment (e.g., IV pole, light, etc.) may be disposed on the top or
21 other surfaces of the systems to enhance system capabilities.

22 It is to be understood that the present invention is not limited to the specific
23 configurations or applications described above, but may be implemented by any system
24 including independently controlled compartments that evenly distribute heat from a heat
25 source to various types of medical or other items.

26 From the foregoing description it will be appreciated that the invention makes
27 available a novel temperature controlled cabinet system and method for heating items to
28 desired temperatures wherein a system housing includes at least one compartment having
29 a heating assembly with a generally U-shaped heating plate to evenly distribute heat to
30 items placed therein.

31 Having described preferred embodiments of a new and improved temperature
32 controlled cabinet system and method for heating items to desired temperatures, it is

1 believed that other modifications, variations and changes will be suggested to those
2 skilled in the art in view of the teachings set forth herein. It is therefore to be understood
3 that all such variations, modifications and changes are believed to fall within the scope
4 of the present invention as defined by the appended claims.

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